DROUGHT AND SASKATCHEWAN RANGELAND

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INTRODUCTION

Most of Saskatchewan Rangeland is located in the semiarid region of the province where drought is a frequent phenomenon. The impact of drought on rangeland can be of serious ecologic and economic consequences. Although drought cannot be controlled, its impact on rangeland and livestock can be moderated by proper management. This booklet outlines a number of practical measures designed to assist the range users minimize the effects of drought and maintain rangeland in healthy condition.

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DROUGHT AND SASKATCHEWAN RANGELAND -

A MANAGEMENT GUIDE

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WHAT IS RANGELAND?

Rangeland is land that is in a natural or seminatural state and supports vegetation suitable for grazing or browsing by livestock. Such land is not cultivated for a variety of reasons: the characteristics of the climate (low precipitation or short growing season); high risk of water erosion (moderate to steep slopes); high risk of wind erosion (sandy topsoil or sparse vegetative cover); or other undesirable physical or chemical attributes (stoniness or salinity). Due to these natural constraints and the delicacy of the ecological balance, rangeland must be managed in such a way as to provide a continuing supply of good quality forage for livestock.

Land that has been ploughed and seeded to exotic forage species (e.g. crested wheatgrass, Russian wild rye or alfalfa) is not rangeland; it is perennial seeded or artificial grassland that is managed as pasture by agronomic principles.

TYPES OF RANGELAND

Saskatchewan has about 24,000,000 acres of rangeland located largely in the subhumid and semiarid climatic regions of the province. Although the main natural vegetation in these regions is a grassland dominated by perennial grasses, other range types are also found, depending on such factors as topography and soil conditions, particularly soil moisture status. These include shrub, woodland, saline wetland, fresh wetland and sand-hill types.

Two zones of grassland can be recognized in Saskatchewan:

1) **Mixed Prairie Grassland Zone:** This zone corresponds with the distribution of the brown and dark brown soils of the province. The main plant species found in this zone are western porcupine grass and needle-and-thread grass, western wheatgrass, northern wheatgrass, blue grama and June grass. The actual makeup of the vegetation and the proportion contributed by each individual species to the total yield vary with such factors as climatic conditions (particularly precipitation), site characteristics and grazing history.
2) **The Fescue Grassland Zone:** The fescue grassland is associated with the black soil zone, mainly north of the Mixed Prairie (a smaller area is found in certain sites in the Cypress Hills region) in the western part of the province. Rough fescue is the main perennial grass species in this zone. Aspen occupies the moister locations here.

RANGELAND AS A COMPLEX ECOLOGICAL SYSTEM

Plants and animals and their environment can be viewed as an ecological system, or ecosystem. An ecosystem is characterized by complex interactions among the various biological and physical components.

Plants function as producers. They combine energy from the sun with carbon dioxide from the air and nutrients from the soil and fix the resultant carbohydrates, proteins and other compounds into plant tissues of leaves, stems and roots. Animals (ungulates, rodents, birds, and invertebrates above the soil surface and invertebrates in the soil) are consumers. Primary consumers (e.g. grazing animals) convert some of the plant materials that they ingest into animal tissues, but most of them are used in animal processes or are passed on as decomposed or partly decomposed wastes. Microorganisms continue this breakdown process, as well as decomposing unconsumed plant materials. Various plant compounds vary in their degree of resistance to decomposition processes. Some materials survive as humus in rangeland soil for hundreds of years. Different types of microorganisms are active at each progressive stage of decomposition and carbon dioxide (through respiration) is lost at each stage of breakdown.

Fig. 1 — Sods of Rough Fescue Clipped in the Greenhouse to Simulate No Grazing, Moderate Grazing, Heavy Grazing, and Very Heavy Grazing. (The decrease in food reserves is shown by the decrease in root volume as the intensity of clipping is increased). (Photo courtesy Agriculture Canada Research Station, Lethbridge, Alberta).

A range ecosystem functions as a unit. Any factor (e.g. grazing, drought) that affects one component usually affect the whole complex. Grazing in excess of that which is natural for the rangeland affects both the vegetative cover and the physical characteristics of the environment (soil and atmosphere around the plants). The effect on the existing plants is to reduce their vigour (height of growth of leaves and stems and depth of roots) (Table 1, Fig. 1). This results

TABLE 1

EFFECT OF GRAZING ON RELATIVE WEIGHT DISTRIBUTION OF ROOTS OF GRASSES BY DEPTH IN A COLORADO RANGE.*

Depth (ft)	Ungrazed	Moderately Grazed	Heavily Grazed
0 - 1	80.0	67.3	51.2
1 - 2	14.5	12.6	7.0
2 - 3	3.1	2.4	0.9
3 - 4	1.1	1.2	0.2
4 - 5	0.4	0.5	0.0
5 - 6	0.1	0.1	0.0
Total	100.0	84.1	59.3

* Calculated from a report of Schuster (1964). Each value is a percentage of the total weight of underground plant parts in the ungrazed treatment.

in lower production rates because there is not as much leaf tissue exposed to the sun and because the volume of soil from which plants can draw moisture is reduced. Low-growing, shallowly-rooted grasses (which are often more drought-resistant) are less affected by this process than are the major forage grasses that are normally dominant in our grasslands. As a result, the area of soil surface occupied by the latter declines and the lower-producing species become more prominant. Another reason for change in the relative abundance of the various species is that some are avoided deliberately by livestock and these are able to compete well with those species that are weakened by grazing. As this process continues, the soil is protected less against the sun, wind and impact of rain drops. The result is a decline in the amount of moisture entering the soil.

Thus, the effects of grazing on grassland are similar to those of drought. The effects of one are additive upon the other. It follows that the effect of drought on rangeland increases with the intensity of grazing that has occurred prior to and during the period of drought.

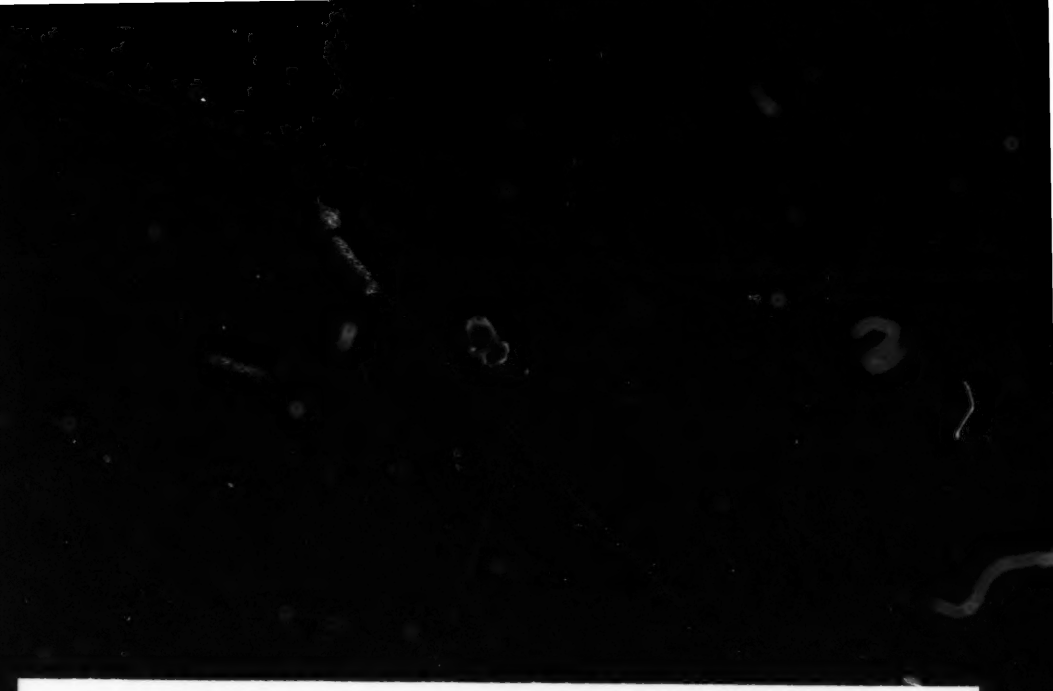

Fig. 2 — A Range Ecologist Examining Range Condition Near Coronach, Saskatchewan.

WHAT IS RANGE MANAGEMENT?

Range management is the practice of manipulating the biological and physical factors of the ecosystem for the purpose of obtaining maximum production of livestock products while maintaining the rangeland in a condition that assures this level of production is sustained.

The term "range site" refers to a distinctive kind of rangeland that differs from other rangeland in its ability to produce a characteristic natural plant community. Consequently, each range site has certain *carrying capacity* (the number of animals that it can support without deteriorating below its present state). A generalized carrying capacity map for Saskatchewan rangeland is given in Fig.3. *Stocking rate* is the number of livestock that is judged to be appropriate to put on range at any particular time.

The basic principle that underlies range management practice is that overgrazing (repeated grazing at too high a stocking rate) causes the carrying capacity to decline, thus resulting in a need to reduce the stocking rate below the level that the range would support had moderate grazing continued. If the stocking rate is not adjusted with the declining condition of the range, deterioration will continue until the land is desertified and is no longer of use as range. In the early stages of this process,

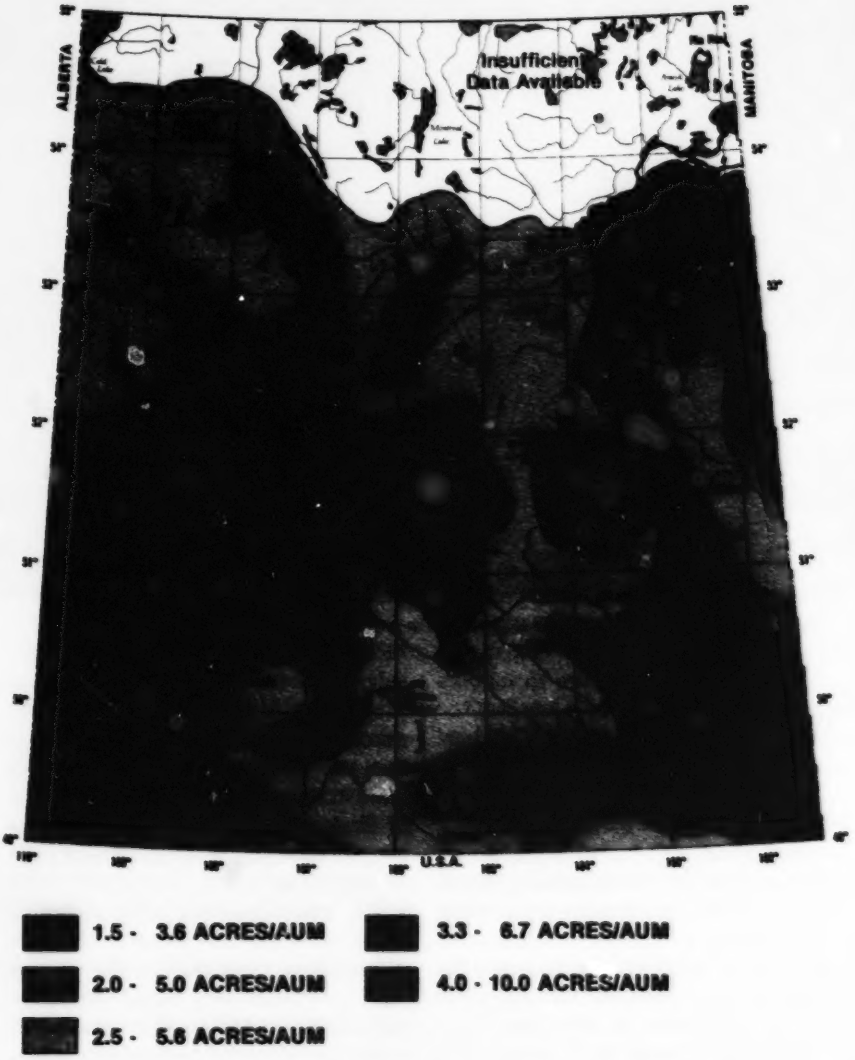

Fig. 3 — Carrying Capacity of Saskatchewan Rangeland in Acres/Animal Unit/Month (AUM) (based on annual precipitation for Saskatchewan using grazing capacity estimates available for Alberta (Sinclair et al 1974). Actual stocking rate should be based on range condition, site characteristics and weather conditions, as explained in the text).

Fig. 4 — Original (Climax) Mixed Prairie Grassland (left) and Overgrazed Area in Fair Range Condition Across the Fence.

the changes can be reversed by setting the stocking rate below the carrying capacity. In the later stages of deterioration, improved management will no longer reverse the process.

In addition to maintaining proper stocking rates, it is important to maintain a uniform grazing pressure over the range. Also, grazing in the spring should not be allowed until the range is "ready". The range is ready when the main species have made substantial growth and replenished the food reserves in their underground parts and when soil conditions are suitable for grazing (not too wet). The date of range readiness varies from one year to another depending on weather conditions. However, where alternative grazing land (e.g. seeded pasture) is available, it is desirable to delay grazing until the middle of June.

The above considerations necessitate monitoring each piece (e.g. field or pasture) of rangeland from time to time to evaluate its condition and to adjust the stocking rate. This is done by measuring the degree to which the relative proportions of the various plant species have changed as compared to the original, slightly grazed or ungrazed grassland (Fig.4) and by noting any changes in soil conditions (e.g. erosion and amount of litter). The original vegetation is used as a benchmark here because it developed over thousands of years and its rate of use of soil nutrients is in balance with the climatic factors.

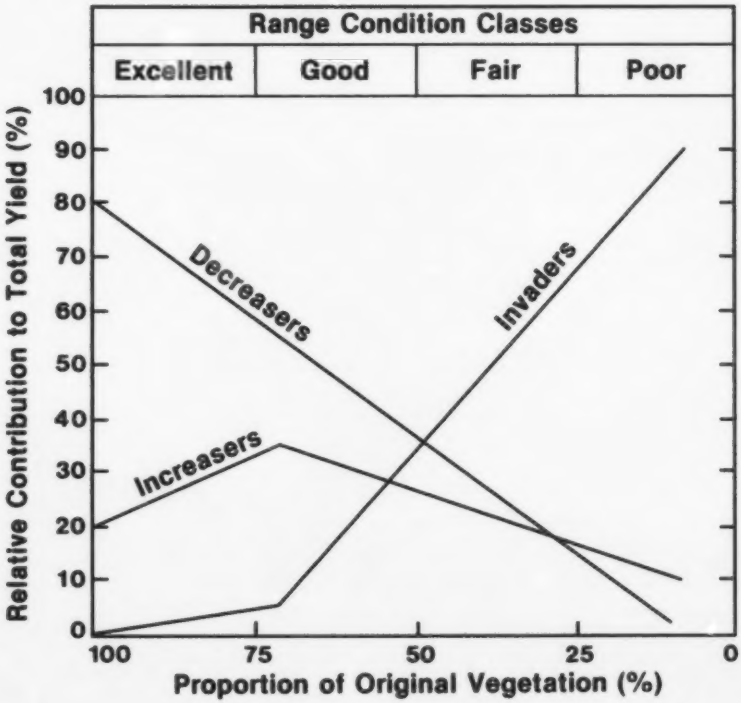

Fig. 5 — Response of Range Plants to Overgrazing and/or Drought.

Some training in species identification and methodology is necessary for the producer to undertake this task (Fig.2). However, the general concept is explained below.

The plant species of rangeland can be grouped into three main categories with respect to their response to grazing (Fig. 5, 6, 7 and Table 2):

1) **Decreasers** are those that decrease in importance as a result of grazing;
2) **increasers** are plants that increase in importance when grazed;
3) **invaders** are those that are not part of the natural plant cover, but appear and increase as heavy grazing weakens the native species.

The latter two categories include some poisonous plants.

Decreasers are the most valuable species because they yield the most forage in relation to the area of the soil surface they occupy. Increasers are lower growing and sometimes less palatable species. In moderately grazed rangeland the balance between decreasers and increasers is maintained at a similar level to that of ungrazed grassland and the range condition is *excellent* to *good*. In heavily grazed range in-

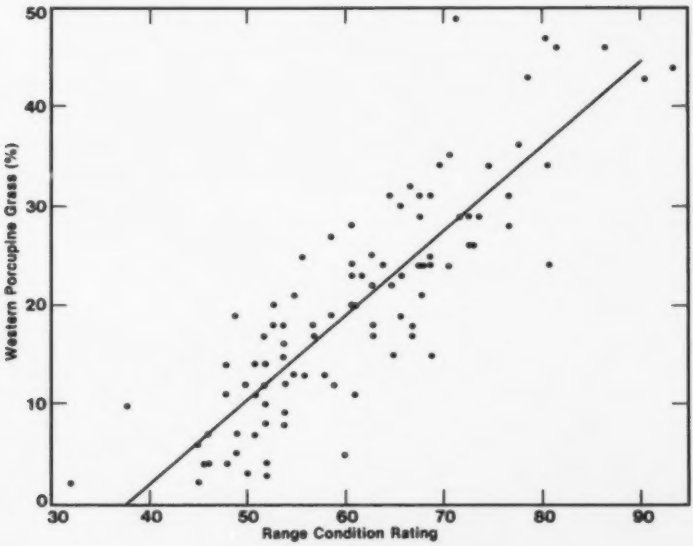

Fig. 6 — Relationship Between the Proportion (% by Weight) of Western Porcupine Grass and Range Condition Ratings in Southeastern Saskatchewan (based on analysis of data collected by Abouguendia et al 1982).

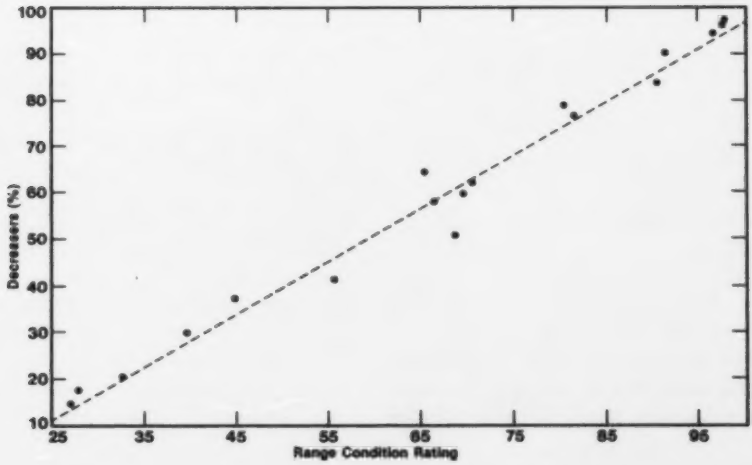

Fig. 7 — Relationship Between the Combined Proportion (% by Weight) of the Main Decreasers and Range Condition (data from Martens 1979 and Godwin et al 1982).

TABLE 2

CLASSIFICATION OF SOME OF THE COMMON SASKATCHEWAN RANGE PLANTS ACCORDING TO THEIR RESPONSE TO OVERGRAZING. (THIS INFORMATION PERTAINS TO NORMAL UPLAND SITES).

Plant Species	Lifeform	Response to Overgrazing		
		Brown Soil Zone	Dark Brown Soil Zone	Black Soil Zone
Blue grama	PG*	INC**	INC	INC
Broom weed	SS	INC	INC	INC
Common yarrow	PF	INC	INC	INC
Foxtail barley	PG	INV	INV	INV
Gumweed	P/BF	INC	INC	INC
June grass	PG	INC	INC	INC
Leafy spurge	PF	INV	INV	INV
Needle-and-thread	PG	DEC	INC	INC
Northern wheatgrass	PG	DEC	DEC	DEC
Pasture (or fringed) sage	SS	INC	INC	INC
Rough fescue	PG		DEC	DEC
Russian thistle	AF	INV	INV	INV
Sheep fescue	PG		INC	INC
Western porcupine grass	PG		DEC	DEC
Western snowberry	S		INC	INC
Western wheatgrass	PG	DEC	INC	INC

*F Forb
G Grass
S Shrub
SS Semishrub
P Perennial
A Annual
B Biennial

** DEC Decreaser
INC Increaser
INV Invader

creasers are able to compete effectively against the weakened decreasers, so that they become progressively more dominant. As heavy grazing continues, even the increasers are weakened and the invaders (weeds) are able to compete against them. The condition of the range thus progresses from *fair* to *poor* (Table 3).

Over grazing is a level at which the rangeland cannot be maintained in good condition, but continues to deteriorate. As this happens it progressively loses capacity to support livestock, and the proper stocking rate required to maintain range condition decreases (Table 4).

TABLE 3

YIELD OF FORAGE (IN POUNDS/ACRE) CONTRIBUTED BY EACH SPECIES OF GRASS AND SEDGE, AS AFFECTED BY VARIOUS INTENSITIES OF GRAZING FOR 19 YEARS BY EWES WITH LAMBS AT MANYBERRIES, ALBERTA.*

Species	Before Study Began (1950)	Yields by Grazing Treatment In Last Year of Study (1969)			
		Not Grazed	Lightly Grazed	Moderately Grazed	Heavily Grazed
Blue grama	33	5	40	46	59
Needle-and-thread	30	110	65	60	25
Western wheatgrass	90	83	109	77	45
Other grasses	39	42	48	45	33
Low sedge	14	6	8	12	17
Total	206	246	170	240	179

*Calculated from basal-area data reported by Smoliak et al (1972) using method of Clarke et al (1942). The stocking rates (in acres per ewe and lamb for a six-month grazing season — May 1 to November 1) were 7.5, 6 and 5, respectively, for the light, moderate and heavy treatments.

TABLE 4

STOCKING RATES, IN ACRES REQUIRED FOR A FIVE-MONTH GRAZING SEASON, AS INFLUENCED BY RANGE CONDITION.*

Vegetation Type	Excellent	Condition Class		
		Good	Fair	Poor
Spear grass** — blue grama	18	22	28	43
Spear grass — blue grama — wheatgrass***	14	18	22	32
Spear grass — wheatgrass	10	12	17	22
Rough fescue	8	10	14	17

* Calculated from Wroe et al (1972).

** Include both needle-and-thread and western porcupine grass.

*** Include both western and northern wheatgrasses.

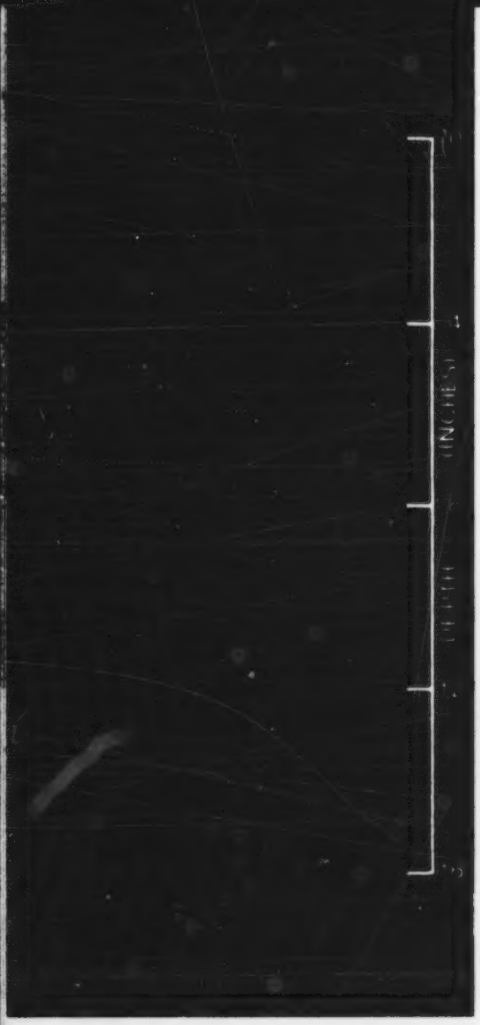

Fig. 8 — An Illustration of Soil Development in a Typical Range Site in Southern Saskatchewan.

DROUGHT AND RANGELAND

A moderately grazed range adjusts to drought by the more drought-resistant plant species (increasers) becoming more prominent at the expense of the higher-yielding species that predominate during periods of higher precipitation. However, the amounts and vigour of the decreasers are sufficient to permit a rapid recovery in forage yield as drought diminishes. Heavily grazed range enters the drought in a weakened condition. The rate of reduction in amount and vigour of decreasers is accelerated by low moisture supply. At the end of the drought, they are so weakened that their response to the better growing conditions is delayed. If heavy grazing occurs in the after-drought period, deterioration will continue (at a slower rate than during drought) and the range will suffer even greater damage during the next drought. After several weather cycles, only the most drought-resistant increasers and invaders will survive. In addition, changes to the soil will make recovery very difficult or impossible.

Rangeland soils developed slowly over thousands of years, but misuse of rangeland often causes it to deteriorate seriously in a relatively short period of time (Fig.8). Grazing results in less moisture penetrating the soil, just as does drought. Both reduce the protection of the soil surface by the vegetation. The forage cover is less because growth is reduced and some of the leaves anddstems have been removed in the grazing process (Table 5). The amount of dead plant material (litter) that lies on the soil surface is also reduced and the soil is exposed to adverse effects of rain, sun and wind. The impact of rain drops breaks down the soil granules on the surface into individual soil particles that plug the pores through which water easily

TABLE 5

A COMPARISON OF THE FORAGE YIELD (IN POUNDS/ACRE) CONTRIBUTED BY EACH GRASS AND SEDGE IN RESPONSE TO A DRY PHASE AND A MOIST PHASE OF THE WEATHER CYCLE IN EIGHT HEAVILY-GRAZED RANGES NEAR SASKATOON, SASKATCHEWAN AND COMPARED TO EIGHT PAIRED UNGRAZED SITUATIONS.*

	In 1952 After a Dry Period		In 1959 After a Moist Period	
Species	Ungrazed	Grazed	Ungrazed	Grazed
Spear grasses **	201	61	365	149
Wheatgrasses ***	93	17	230	94
Blue grama	15	40	14	56
June grass	41	41	34	75
Rough fescue	35	3	41	0
Other grasses	4	2	13	12
Low sedge	25	25	34	39
Other sedges	8	9	21	19
Total	422	198	752	444

* Calculated from data reported by Coupland et al (1960), using the method of Clarke et al (1942).

** Needle-and-thread and western porcupine grass.

*** Western wheatgrass and northern wheatgrass.

enters the soil when it is well protected. Water puddles on the surface and is lost by runoff and by evaporation. The soil surface dries up more rapidly after rain, since the soil is warmer because of direct exposure to the sun. Exposure to the wind results in erosion of the dispersed, dry, unprotected soil particles, resulting in dust storms. All of these factors cause conditions that are unfavorable for plant growth. Less organic matter is produced, more is removed, and less is available to be converted into the organic reserve in the soil. This deterioration will eventually lead to complete desertification and irreversible damage to the rangeland.

These are the factors that have resulted in the devastation that is currently being publicized in the rangelands of many parts of Africa. Rangeland is being converted to desert in many other developing countries as well. Lack of recognition that range deterioration results from over-stocking leads to the belief that the cause is drought, even during favourable phases of the weather cycle. The performance of livestock during drought is affected by the condition of the rangeland at the beginning of the period of drought. If the range is in good condition, its carrying capacity will be less affected by drought than if it is in fair to poor condition. This means that the stocking rate of range in good condition can be maintained during one or two dry years with only moderate effects on the vegetation and animal performance. However, in range that is in fair to poor

TABLE 6

RANGE IN WEIGHT GAIN OF CATTLE (IN POUNDS) DURING A SIX-YEAR (1932 to 1937) GRAZING EXPERIMENT AT MANYBERRIES, ALBERTA.*

Area Allowed for Cow and Calf (Acres)	Weight Gain of Cows		Weight of Calves in Fall	
	Poorest Year	Best Year	Poorest Year	Best Year
40	172	322	366	420
30	102	334	359	425
20	22	319	322	389

* Taken from a report of Clarke et al (1943). The grazing season was from April to October (7 months). In ungrazed grassland, forage yield was 365 lb/acre in the best year and 163 lb/acre in the poorest year, compared to the long-term average of 317 lbs/acre. Precipitation during April to July was 7.7 inches in the best year and 2.6 inches in the poorest year, compared to the long-term average of 5.8 inches.

condition, stocking rate must be sharply reduced early in drought or the livestock will suffer severely, the vegetation will deteriorate rapidly, and recovery will be slow after the drought.

Livestock on over-stocked ranges make poorer weight gains, bring lower prices per unit of weight, exhibit lower reproductive rates, and take longer to reach maturity (e.g. breeding age) (Table 6). The result is that more forage is required for grazing and more stored feed and concentrates are required because of the need to support more animals per unit of output. This is the situation during periods of good moisture supply in ranges that are over stocked. During dry years this situation prevails even in ranges that were previously grazed moderately. In fair to poor ranges many animals die during dry years unless the stocking rate is sharply reduced.

Fig. 9 — Example of Areas Differing in Range Condition. The area to the left represents a range in the upper good range condition class, while the area across the fence is a typical example of areas in the fair range condition class.

HOW TO MINIMIZE THE IMPACT OF DROUGHT

Drought cannot be controlled but its impact can be moderated by proper livestock management. It should be remembered that the rate of vegetative recovery from the effects of drought depends greatly on the pre-drought range condition. Ranges originally in good to excellent condition recover much more rapidly than do ranges in poor to fair range condition (Fig.9). It is, therefore, essential to keep your range in good condition. To assist in achieving this goal, the following practical measures are suggested.

Periodically evaluate the condition of your range by comparing the proportion of decreaser species as compared to increaser species and be very wary if invader species appear.

Rectify any indication of increase in the proportion of less desirable species by reducing the stocking rate, so as to permit range condition to improve by natural means. Beware of a reoccurrence of decline in range condition by maintaining a stocking rate below that which previously caused range condition to deteriorate.

Make sure enough foliage is left each year at the end of the grazing season to allow the plants to manufacture their own food and build strong roots early in the following spring. A rule of thumb suggests grazing half and leaving half of the total yield. The ungrazed half, or "carryover", is not wasted. It is essential for maintenance of the ecosystem.

Maintain as uniform as possible distribution of animals over the range. This can be done through one or more of the following measures:

1) Cross fencing.
2) Manipulation of watering points and moving salting grounds.
3) Fertilization of ungrazed or slightly grazed areas.
4) Herding.

Grazing plans should allow for variations in production attributable to weather conditions. Even under conservative stocking based on average production, shortages of forage can be expected to occur during subnormal (dry) years. When a dry phase of the weather cycle begins, do not delay long in reducing the stocking rate. The sooner the number of animals is reduced, the smaller the reduction will need to be.

Accumulate feed reserves during favourable years well beyond current needs, so that feed will be available in dry years. In this way, it may be possible to reduce the grazing pressure on land that is regularly grazed by grazing hay fields rather than cutting them.

Grazing pressure on rangeland can be lessened by using seeded pastures in spring and fall. Emphasis should be placed on the proper selection of seeding sites and adapted species. Crested wheatgrass pastures provide good grazing in spring, when rangeland may be more susceptible to damage from grazing. Similarly, Russian wild rye pastures provide nutritious forage in the fall after the range forage has cured. Also, some species or cultivars survive drought better than others. For example, Swift and Vinall Russian wild rye grass perform better during drought than Nordan crested wheatgrass (Currie and White 1982). However, care must be taken not to depend, in dry years, on seeded pastures that are fully used in good years. Unfortunately, forage yield in pastures seeded to exotic grasses is depressed more (proportionately) in dry years than is that of the native grasses in rangeland. This is particularly true of old stands of exotic grasses.

The application of nitrogen fertilizer is a means of increasing yield and protein content of native grasses when sufficient soil moisture is available to permit increased growth. Unfortunately, this method is very costly and is not effective during drought, because of deficient soil moisture.

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GLOSSARY

AU (Animal Unit): A mature (450 kg, 1000 lb) cow, with or without an unweaned calf at side; or the equivalent.

CARRY-OVER: The amount of forage remaining in a rangeland unit at the end of the grazing season.

CARRYING CAPACITY: The maximum animal numbers which can graze each year on a given area of a range for a specific number of days, without inducing a downward trend in forage production, or forage and soil quality.

CLIMAX: The potential (original) natural vegetation of a range site.

CONSUMERS: Organisms, mainly animals, which ingest other organisms or organic matter. Primary consumers are those animals that depend on the utilization of plant material.

DECREASERS: Range plant species that decline in abundance in response to overgrazing.

ECOLOGY: The study of the organisms-environment relationships.

ECOSYSTEM: A group of plants and animals which are interrelated with each other and with their environment so as to form a unified whole.

INCREASERS: Range plant species that initially increase in abundance in response to overgrazing, but may decline during advanced stages of range deterioration.

INVADERS: Range plant species that are not considered as part of the original natural vegetation.

PRODUCERS: Largely green plants which are able to fix the energy of the sun and manufacture food from simple inorganic substances.

RANGE CONDITION: The present state of vegetation and soil of a range site.

RANGE READINESS: A term used to describe the suitability of rangeland for grazing in the spring and early summer. Range is ready for grazing when the soil has become firm after winter and spring precipitation and when plants have reached a certain stage of growth at which grazing is not damaging.

RANGE SITE: A specific type of rangeland differentiated from other types of rangeland on the basis of its ability to produce a characteristic natural plant community.

STOCKING RATE: The actual number of animals on a specific range area for a specific period of time, usually a grazing season.

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GLOSSARY